

**SYSTEM, METHOD AND SOFTWARE FOR
A SPEECH-ENABLED CALL ROUTING APPLICATION
USING AN ACTION-OBJECT MATRIX**

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to speech recognition and, more particularly, to speech recognition enabled automatic call routing service systems.

BACKGROUND OF THE INVENTION

Developments in speech recognition technologies support more natural language interaction between services systems and customers than that previously supported. One of the most promising applications of these new technologies is Automatic Call Routing (ACR). The goal of an ACR application is to determine why a customer is calling the service center and to route the customer to the most appropriate agent for servicing a customer request. Speech recognition technology generally allows an ACR application to recognize natural language statements so the application does not have to rely on a menu system. This allows the customer to state the purpose of their call "in their own words".

In order for an ACR application to properly route calls, the ACR must generally interpret the intent of the customer, identify the type or category of customer call, and then identify the correct routing destination for the call type. Identification of all the possible call types is a time intensive and extensive phase of the service center development process, because the call types are not usually known prior to ACR development.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present embodiments and advantages thereof may be acquired by referring to the following description taken in 5 conjunction with the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIGURE 1 is a schematic diagram depicting one embodiment of a telecommunications system incorporating teachings of the present invention;

10 FIGURE 2 is a schematic diagram depicting an alternate embodiment of a telecommunications system incorporating teachings of the present invention;

15 FIGURE 3 is a schematic diagram depicting a further embodiment of a telecommunications system incorporating teachings of the present invention;

FIGURE 4 is a block diagram depicting an exemplary embodiment of a service center system incorporating teachings of the present invention;

20 FIGURE 5 is a flow diagram depicting one embodiment of an action-object based speech recognition enabled automatic call routing method incorporating teachings of the present invention; and

25 FIGURE 6 is a diagram illustrating one embodiment of an action-object matrix incorporating teachings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Preferred embodiments and their advantages are best understood by reference to FIGURES 1 through 6, wherein like numbers are used to indicate like and corresponding parts.

Referring first to FIGURE 1, a schematic diagram of an exemplary embodiment of a telecommunications system, indicated generally at 10 is shown. Telecommunication system 10 may include communication network 12 in communication with one or more gateway devices 14 and 16. Input/output (I/O) devices 18 and 20 are each preferably in communication with respective gateway devices 14 and 16. Accordingly, I/O devices 18 and 20 may be in selective communication with each other via gateway devices 14 and 16, and communication network 12.

In one embodiment, communication network 12 may be a public switched telephone network (PSTN). In alternate embodiments, communication network 12 may include a cable telephony network, an IP (Internet Protocol) telephony network, a wireless network, a hybrid Cable/PSTN network, a hybrid IP/PSTN network, a hybrid wireless/PSTN network or any other suitable communication network or combination of communication networks.

Gateways 14 and 16 preferably provide I/O devices 18 and 20 with an entrance to communication network 12 and may include software and hardware components to manage traffic entering and exiting communication network 12 and conversion between the communication protocols used by I/O devices 18 and 20 and communication network 12. In some embodiments, gateways 14 and 16 may function as a

proxy server and a firewall server for I/O devices 18 and 20. In some embodiments, gateways 14 and 16 may be associated with a router (not expressly shown), operable to direct a given packet of data that arrives at gateway 14 or 16, and a switch (not expressly shown), operable to provide a communication path in and out of gateway 14 or 16.

In the present embodiment, I/O devices 18 and 20 may include a variety of forms of equipment connected to communication network 12 and accessible to a user. I/O devices 18 and 20 may be telephones (wireline or wireless), dial-up modems, cable modems, DSL (digital subscriber line) modems, phone sets, fax equipment, answering machines, set-top boxes, televisions, POS (point-of-sale) equipment, PBX (private branch exchange) systems, personal computers, laptop computers, personal digital assistants (PDAs), SDRs, other nascent technologies, or any other appropriate type or combination of communication equipment available to a user. I/O devices 18 and 20 may be equipped for connectivity to communication network 12 via a PSTN, DSLs, a cable network, a wireless network, or any other appropriate communications channel.

Referring now to FIGURE 2, a block diagram of an exemplary embodiment of a telecommunication system 22 is shown. In the exemplary embodiment shown, system 22 preferably includes a PSTN 24 and cable head-end 26 in communication with cable distribution network 28. PSTN 24 may be in operable communication with host digital terminal (HDT) 30 and function to convert signals

received from PSTN 24 for transmission over cable networks. Host digital terminal 30 and cable head-end 26 may be in communication with combiner 32. Combiner 32 may communicate data received from cable head-end 26 5 and/or PSTN 24 to cable distribution network 28. Cable distribution network 28 may further communicate data to network interface device 34 to a user via telephone 36, computer 38, television 40 or any other suitable I/O device. Cable head-end 26 may provide cable television 10 programming and cable modem communications. Cable head-end 26 typically includes a cable modem termination system (not expressly shown) for sending and receiving digital cable modem signals.

Referring next to FIGURE 3, a block diagram of an 15 exemplary embodiment of a telecommunication system 42 is shown. This exemplary embodiment generally includes interconnected IP network 44, PSTN 46, and cable distribution networks 48 and 50. IP network 44 may include media gateway controller 52, media gateway 54, 20 and signaling gateway 56. Media gateway 54 and signaling gateway 56 may be in operative communication with PSTN 46 and facilitate communication of information therebetween. IP network 44 may further communicate with cable distribution networks 48 and 50 via cable modem 25 termination systems (CMTS) 58 and 60, respectively. CMTS 58 and 60 may convert IP packets received from IP Network 44 for transmission on cable distribution networks 48 and 50 and convert signals received from cable distribution networks 48 and 50 into IP Packets for transmission to IP 30 Network 44. Cable distribution networks 48 and 50 may

communicate information with users via network interface terminals 62 and 64. Network interface terminals 62 and 64 may provide data services to users through I/O devices such as, telephones 66 and 68, computers 70 and 72, and 5 televisions 74 and 76. One or more data services may also be provided to a user through PSTN 46 and one or more I/O devices such as telephone 65.

Telecommunication system 42 of FIGURE 3 preferably allows transmission of services to be delivered to users 10 where such services include, without limitation, voice over Internet protocol ("VoIP"), video over Internet, video-on-demand over broadband connections, and the ability to view television and film images as well as broadcasts. In addition, one of ordinary skill will 15 appreciate that other embodiments can be deployed with many variations in the number and type of I/O devices, communication networks, the communication protocols, system topologies, and myriad other details without departing from the spirit and scope of the present 20 invention.

Referring now to FIGURE 4, a block diagram illustrating one embodiment of a service center incorporating teachings of the present invention is shown. While reference herein is made primarily to a 25 customer service call center, alternate implementations of teachings of the present invention may be employed without departing from the spirit and scope thereof.

Illustrated generally at 100 is one embodiment of a system operable to permit a user to perform one or more 30 transactions via a plurality of service agents available

from a service center. As illustrated in FIGURE 4, system 100 preferably includes service center 102. Service center 102 may include one or more computing apparatuses 104 operably coupled to one or more 5 transaction processing service solutions 106.

Preferably included in communication apparatus 104, is processor 108. Operably coupled to processor 108 of computing apparatus 104 is memory 110. Computing apparatus 104 preferably employs processor 108 and memory 10 110 to execute and store, respectively, one or more instructions of a program of instructions.

Also included in computing apparatus 104, as illustrated in FIGURE 4, is communication interface 112. Communication interface 112 is preferably operable to 15 couple computing apparatus 104 and/or service center 102 to an external communication network 114. According to teachings of the present disclosure, communication network 114 may be implemented as a PSTN, a cable 20 telephony network, an IP telephony network, a wireless network, a hybrid cable/PSTN network, a hybrid IP/PSTN network, a hybrid wireless/PSTN network, or any other suitable communication network or combination of communication networks.

Communication interface 112 preferably cooperates 25 with communication network 114 and user communication device 116 to permit a user to perform one or more transactions via service center 102. As described above, user communication device 116 may be a wireless or wireline telephone, dial-up modem, cable modem, DSL

modem, or any other appropriate type or combination of communication equipment available to a user.

In operation, service center 102 preferably permits a user to, in their natural language, request processing 5 or performance of one or more transactions available from transaction processing service solutions 106. To enable such processing, computing apparatus 104 may include or have access to one or more storage devices 118 including one or more programs of instructions substantially 10 operable to interpret the intent of a user, identify a solution sought by the user and route the user to an appropriate service solution agent.

To aid in the interpretation, identification and routing operations of service center 102, storage 118 15 preferably includes action-object matrix 120, look-up table 122, utterance storage 124, prompt library 126, as well as one or more speech recognition capabilities, such as statistical language modeling engine 128. Additional detail regarding the operation and cooperation of the 20 various components, preferably included in storage 118, will be discussed in greater detail below.

In one embodiment of the present invention, computing apparatus 104 is preferably communicatively coupled to one or more connection switches or redirect 25 devices 130. Connection switch or redirect device 130 preferably enables computing apparatus 104, upon determining an appropriate destination for the processing of a user selected transaction, to route the user via communication network 132 and, optionally, one or more

switches 134, to an appropriate agent or module of transaction processing service solution 106.

Transaction processing service solution 106 preferably includes a plurality of agents or modules 5 operable to perform one or more operations in association with the processing of a user selected transaction. For example, transaction processing service solution 106 may include one or more agents or modules operable to perform billing service solutions 136, repair service solutions 10 138, option service solution 140, basic service solutions 142, as well as other service solutions. In addition, the agents or modules implemented in or in association with transaction processing service solutions 106 may include, but are not limited to, automated or self- 15 service data processing apparatuses, live technician support (human support), as well as combinations thereof.

Referring now to FIGURE 5, one embodiment of a method for a speech-enabled call routing call application using an action-object matrix is shown according to 20 teachings of the present invention. As mentioned above, method 150 of FIGURE 5 may be implemented in one or more computing apparatuses 104 of one or more service centers, such as a telecommunications call service center. Upon initialization at 152, method 150 preferably proceeds to 25 154. At 154, method 150 preferably provides for and awaits an incoming contact from a user. In one embodiment, method 150 at 154 may await user contact via user communication device 116 across communication network 114 with communication interface 112 of computing 30 apparatus 104. Myriad embodiments of user contact with a

service or call center are contemplated within the spirit and scope of the teachings of the present disclosure.

Upon detection of an incoming contact at 154, method 150 preferably proceeds to 156 where a communication 5 connection with the incoming contact is preferably established. As suggested above, establishing a communication connection with an incoming contact at 156 may include, but is not limited to, receiving a user phone call via a PSTN or a wireless network, as well as 10 numerous other communication connection implementations.

Once a communication connection has been established at 156, method 150 preferably proceeds to 158. At 158, one or more prompts may be communicated to the user. In one aspect, the communication of one or more prompts at 15 158 is aimed at eliciting from the user via the communication connection a request for the processing of one or more desired transactions or operations. For example, computing apparatus at 158 may access prompt library 126 of storage 118 to generate a user transaction 20 selection prompt such as, "Thank you for calling our service center. Please tell me how we may help you today." Alternate embodiments of generating one or more prompts configured to elicit user selection of a desired transaction are contemplated within the spirit and scope 25 of teachings of the present invention.

At 160 of method 150, user response to the communicated prompt at 158 is preferably awaited. Upon detection of a user response at 160, method 150 preferably proceeds to 162 where a natural language 30 utterance of the user in response to the prompt

communicated at 158 is preferably received. Receipt of a natural language utterance from a user at 162 may include storage of the user's natural language utterance in utterance storage 124 of computing apparatus storage 118.

5 Permanent or temporary storage of a natural language user utterance, such as in utterance storage 124, may enable or simplify the performance of speech recognition analysis thereon.

Following receipt of a natural language user utterance at 162, method 150 preferably proceeds to 164. At 164, the user's natural language utterance is preferably evaluated in pursuit of interpreting or identifying the intent of the user and the operation or processing requested. In one embodiment of the present invention, evaluation of a natural language user utterance at 164 may include the use of one or more speech recognition technologies, such as that available from statistical language modeling engine 128 of computing apparatus 104. By evaluating the natural language user utterance at 164 using speech recognition technology, such as statistical language modeling engine 128, recognition of a natural language transaction selection may be achieved. As suggested above, statistical language modeling engine 128 may cooperate with utterance storage 124 in its performance of natural language user utterance evaluation at 164.

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According to teachings of the present invention, statistical language modeling engine 128 preferably evaluates the natural language user utterance received at 162 in cooperation with action-object matrix 120. In the

evaluation of a natural language user utterance at 164, the speech recognition technology preferably employed by computing apparatus 104 seeks to identify an action, an object or an action-object combination from the natural 5 language user utterance. The provision of action-object matrix 120 simplifies and reduces the development costs of automated call routing applications. By creating a finite number of transaction options via action-object matrix 120, proper routing of a user to a service agent 10 or module 136, 138, 140 or 142, may be accomplished with great efficiency, i.e., substantially eliminating user routing errors and, therefore, user re-routing.

As at least a portion of the natural language user utterance evaluation performed at 164 includes seeking 15 whether the natural language user utterance includes an action, object or action-object combination, method 150, at 166, preferably determines whether a natural language user utterance includes either an "action" 168, an "object" 170, an "action-object" combination 172 or other 20 information 174.

If at 166 it is determined that the natural language user utterance contains only an action 168, method 150 preferably proceeds to 176 where one or more additional prompts may be communicated to the user. The prompts are 25 preferably directed to eliciting an object selection in a subsequent natural language user utterance. For example, referring to the action-object matrix depicted in FIGURE 6, it may have been determined from the natural language user utterance that the user desires to inquire as to 30 certain aspects available from service center 102.

Having identified that the user wishes to make an "inquiry", computing apparatus 104 may cooperate with prompt library 126 and action-object matrix 120 to prompt the user for selection of an "object" associated with the 5 "inquire" action. As illustrated in FIGURE 6, examples of objects associated with the "inquire" action include, but are not limited to, in one embodiment, optional services, basic service, billing, cancellation, repair, payment, specials as well as name and number.

10 Similarly, if at 166 it is determined that the natural language user utterance contains only an "object" 170, method 150 preferably proceeds to 178 where one or more prompts for a natural language utterance from the user preferably containing an "action" selection may be 15 generated. Referring again to the action-object matrix generally depicted in FIGURE 6, if it is determined from the natural language user utterance that the user desires transaction processing in association with a service bill, computing apparatus 104 may cooperate with 20 action-object matrix 120 and prompt library 126 to generate one or more prompts directed to eliciting user selection, in their own words, of an "action" associated with the bill "object". As shown in FIGURE 6, examples of actions associated with the bill object may include, 25 but are not limited to, in one embodiment, inquiry, information, fixing or repairing and paying.

It should be understood that the action-object matrix depicted generally in FIGURE 6 is included primarily for purposes of illustration. As such, 30 alternate embodiments of an action-object matrix such as

the action-object matrix depicted in FIGURE 6 may be implemented without departing from the spirit and scope of teachings of the present invention.

If at 166 evaluation of the natural language user 5 utterance leads to identification of neither an "action" 168, "object" 170 nor an "action-object" combination 172, method 150 preferably proceeds to 180 where a disambiguation dialogue may be initiated and performed. In one example, it may be determined at 166 that the 10 contents of the natural language user utterance contains more than one action available in an associated action-object matrix, more than one "object" available in an associated action-object matrix, no indication of an "action" nor an "object", as well as other information 15 failing to indicate user selection of a desired transaction. In such an event, method 150 preferably provides for additional dialogue to be performed with the user in an effort to elicit an "action-object" combination from the user. Following prompting for an 20 "object" at 176, for an "action" at 178 or initiation and performance of disambiguation dialogue at 180, method 150 preferably returns to 160 where a response may be awaited as described above. Method 150 then preferably proceeds through the operations at 162, 164 and 166, in one 25 embodiment, until an action-object combination 172 has been elicited from the user in a natural language utterance.

Following identification from the user's natural language utterance of an action-object combination 172, 30 method 150 preferably proceeds to 182. At 182, computing

apparatus 104 preferably cooperates with action-object matrix 120 and look-up table 122 to identify a preferred or proper routing destination for processing of the user's selected transaction. As suggested above, the 5 routing destinations identified at 182 may include routing destinations associated with the agents or modules available in transaction processing service solutions 106. Agents or modules 136, 138, 140 and 142 may include automated transaction processing available 10 via computing apparatus 104 or a similar device, live support, combinations thereof, as well as other transaction processing options.

Following identification of a preferred or proper routing destination at 182, method 150 preferably 15 proceeds to 184. At 184, the user connection is preferably routed to the appropriate, proper or preferred routing destination indicated in look-up table 122. Following the routing of the user connection at 184, method 150 preferably returns to 154 where the next user 20 connection may be awaited.

Referring again to FIGURE 6, an action-object matrix incorporating teachings of the present invention is shown. As shown in FIGURE 6, action-object matrix 200 preferably includes a plurality of columns or rows, 25 depending on implementation, of actions 202. Action-object matrix 200 preferably also includes a plurality of rows or columns, again depending upon implementation, of objects 204. The intersection of an action row or column with an object column or row, 30 respectively, generally defines a transaction or task

available from service center 102 via, for example, one or more service modules or agents 136, 138, 140 and 142.

In accordance with teachings of the present invention, service center 102, method 150 and 5 action-object matrix 200 preferably cooperate to interpret user intent, identify a desired transaction and the correct routing destination from natural language user utterances. For example, using actions 202 and objects 204 of action-object matrix 200, in conjunction 10 with method 150, a natural language user utterance such as, "How much do I owe on my bill?" may be evaluated to contain the action-object combination inquire/bill 206. In a further example, the natural language user utterance, "I have a problem with a charge on my bill" 15 may produce the action-object combination fix-repair/bill 208. In still another example, the natural language user utterance, "Where can I go to pay my phone bill?" may be evaluated to include the action-object combination of where/payment 210. In yet another example, the natural 20 language user utterance, "How do I set up Call Forwarding?" may be evaluated to include the action-object combination how-to-use/option services 212. In yet another example, the natural language user 25 utterance, "I'd like to get Call Notes." may be evaluated to include the action-object combination acquire/optional services 214.

As mentioned above, action-object matrix 200, such as may be stored in action-object matrix storage 120, preferably cooperates with a look-up table to identify 30 the routing destination associated with an identified

action-object combination. For example, upon identifying action-object combination inquire/bill 206 from a natural language user utterance, computing apparatus 104 may utilize action-object matrix storage 120 and look-up table 122 to determine that the appropriate routing destination for inquire/bill action-object combination 206 is bill agent or module 136 of transaction processing service solution 106. In another example, upon identifying action-object combination fix-repair/bill from a natural language user utterance, computing apparatus 104 cooperating with action-object matrix storage 120 and look-up table 122 may determine that an appropriate routing destination for the user connection includes repair, agent or module 138 of transaction processing service solutions 106. Additional implementations of associating a look-up table with an action-object matrix may be utilized without departing from the spirit and scope of teachings of the present invention.

20 Although the disclosed embodiments have been described in detail, it should be understood that various changes, substitutions and alterations can be made to the embodiments without departing from their spirit and scope.